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BULLETIN OF THE INTERNATIONAL OCEANOGRAPHIC FOUNDATION

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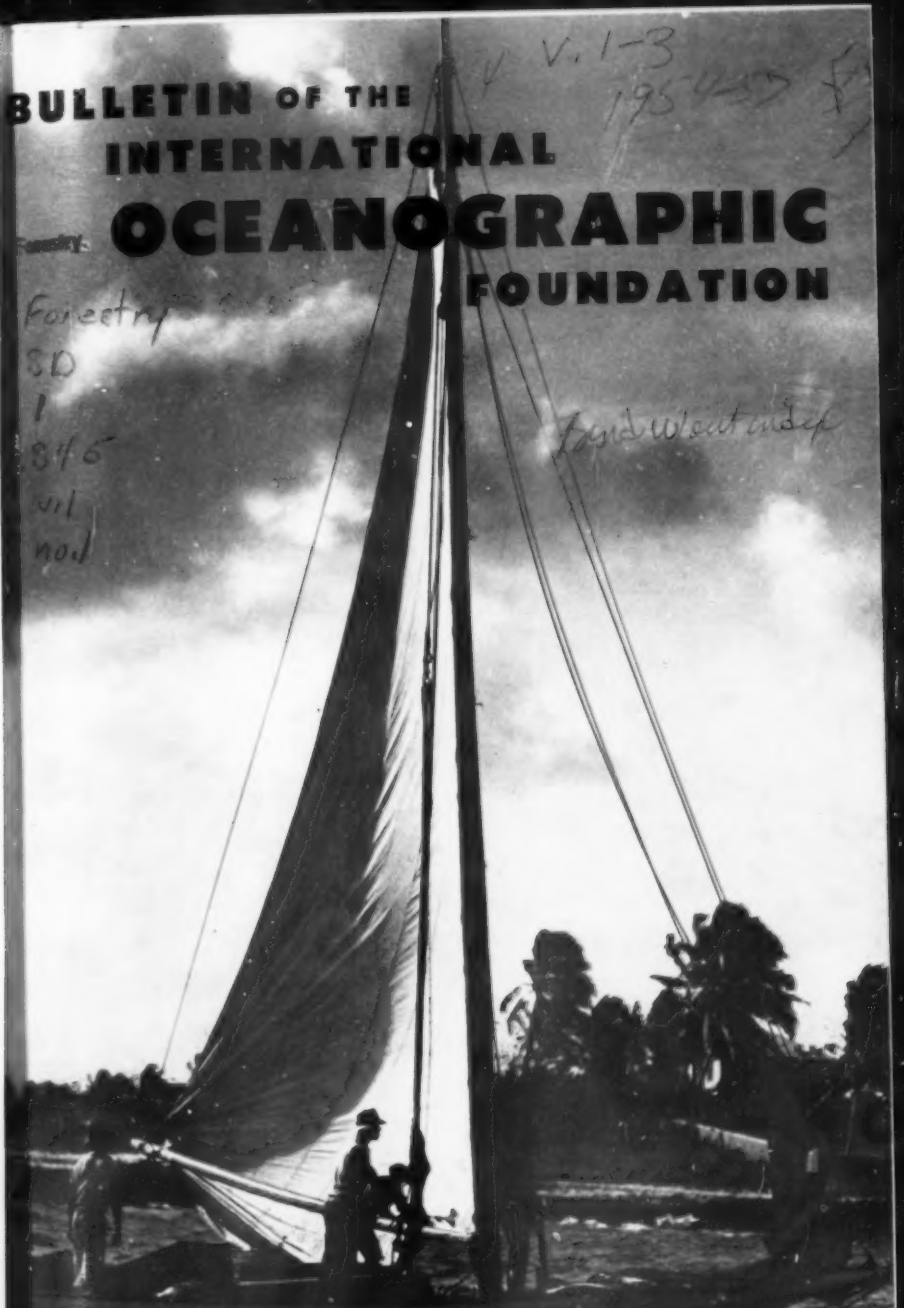

November, 1954 Volume I, Number 1
THE MARINE LABORATORY, University of Miami, Coral Gables, Florida

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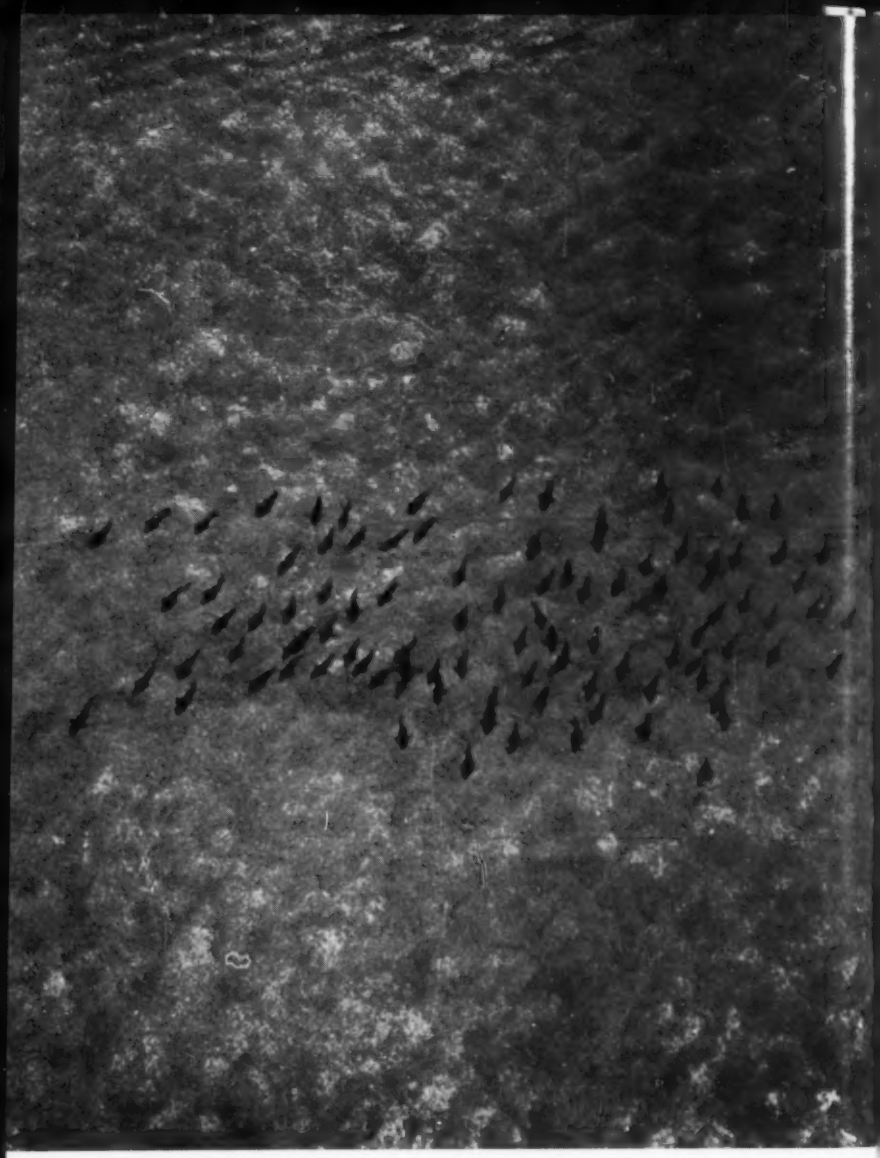

Giant Bluefin Tuna seen from the air off Cat Cay, Bahamas—See story on page 11

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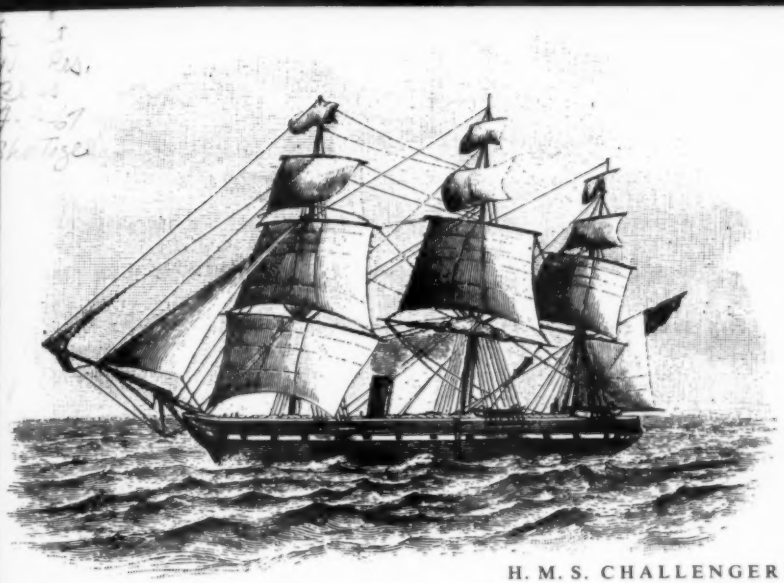
Editorial Office: The Marine Laboratory, University of Miami, Coral Gables, Fla.



H. M. S. CHALLENGER

For Peace and Plenty

by F. G. WALTON SMITH

TOWARDS THE END of the last century, HMS CHALLENGER began her celebrated 3 year voyage round the world for the purpose of a scientific exploration of the virtually unknown oceans, their depths and their life. This was the first time that a full-scale oceanographic survey had ever been attempted. Since then the sciences of the sea have developed a long way, but the greatest advances have only been made during the past three decades. Oceanography is still a young science. Why then is it so important to the world?

The importance of seagoing sciences to the nation in undersea warfare, and in surface warfare is obvious. It is also clear that, since the ocean covers 7/10 of the earth's surface, the problems of weather forecasting and storm and hurricane predictions, and control, must be closely linked to scientific studies made at sea. The engineering problems of ships in a seaway and the engineering problems of beach erosion come within the oceanographer's horizon. Control of shipworms and other marine borers which do damage totalling millions of dollars in any one year, and the control of barnacles and other fouling organisms on ships' bottoms are likewise based on the findings of ocean scientists. But there are other problems of vaster extent which may affect the entire future of the civilized world. In these are the reasons that, though the youngest of sciences, oceanography may be destined to be one of the most important to the human race. And, to understand this, we must go back a few hundred years.

Equation of Hunger

At the time of Columbus there was only a limited area of land available

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HUNDREDS OF YARDS *of stout line, numerous floats and flags and hundreds of hooks make up the long line here being handled by Peruvian fishermen during the Pacific Billfish Expedition.*

to the European center of civilization. With just so much land there was just so much food and fuel and materials for clothing and industry. And so, except for minor changes due to slow improvements in agricultural science, there was a limit to the number of people who could be supported by the land—so many mouths per acre. Of course, lacking any control of the runaway fertility of the human race more were born than could be fed. But the size of population remained fairly stationary, as the surplus humans died of famine, pestilence, war and other natural controls.

Brave New World

The situation changed rapidly after Columbus, and others before and after him opened a great new area of land, first in the Americas and later in Africa, Australia and New Zealand. With new land to develop and food for those who would put their backs to the plough, the human population, unchecked, began the greatest increase of all time. And this has been going on right into the present century. But today there is no great new land area to develop and no sure outlet for a great growth of population, which now amounts to 70,000 new mouths to be filled each day.

The Last Horizon

Whatever improvements may be made in agriculture, the area of land is limited and there must obviously be a limit to the food it will supply.

Over most of the world today this limit is already exceeded and millions are already suffering from undernourishment. As the strains set up by growing populations and limited land areas become worse, we can hardly expect countries already dangerously crowded to look without jealous eyes at the more fortunate western civilization. Only if we find a new frontier with potentially great resources of food and minerals, open to all nations, can we expect to enjoy even our present precarious peace and plenty. And this is where we look to the sea.

More than half of the earth's surface is covered to a depth of at least two miles by saltwater. In the frontier of the seas, oceanographers have calculated that nearly nine times as much vegetation grows as on land. This microscopic plant life we call plankton, as it drifts through the vast saltwater prairies. If we are one day able to use it, even if only for cattle food, the effect would be the same as a vast New World to absorb the growing human race. Even were we able, by research and engineering, to use our fishery stocks to the full, we should have a great new supply of food. But today the fur seals of the Alaskan Islands and the birds of the shore eat more fish than our fishermen bring back. There are great food potentials in the sea—when we have learned how to use them.

Mining the Sea

What has been said about food is even more true of minerals. At least food is renewable. Every day the sun rises it pours energy into the leaf factories of plants which by their growth renew daily our bread, within the limits of what the land can produce. But minerals, once taken from the mines, are not replaced. As these concentrated ore pockets are used up, we are forced to use poorer and poorer grades at greater and greater expense.

The Sea, however, is a great reservoir into which rivers bring the products of erosion and decay, the mineral runoff of the land. Here is a practically limitless source of all the minerals and metals we use—but in great dilution. Bromine is used for gasoline antiknock compounds and there are millions of millions of tons of this element in the seas. But in one ton of sea water there are only about two ounces of bromine. Nevertheless, most of our bromine today is commercially extracted from this dilute sea solution. Scientific research has already paid off.

What is true of bromine is true of magnesium. All of this valuable metal used in the United States comes from sea water. Whether we shall substitute the ocean for our vanishing mines depends on the vigor with which we apply science to the problem. We are even concerned with shortage of fresh water in many otherwise valuable areas of land. The oceans contain 300 million cubic miles of water available to us—when we learn to separate it commercially and economically from the salt it contains.

Science and Freedom

The great challenge offered by the ocean for the enrichment of our resources and the part it must play in our future as well as the pressing problems of today—these can only be met by sustained scientific research. The very survival of nations rests on superiority in science and technology.

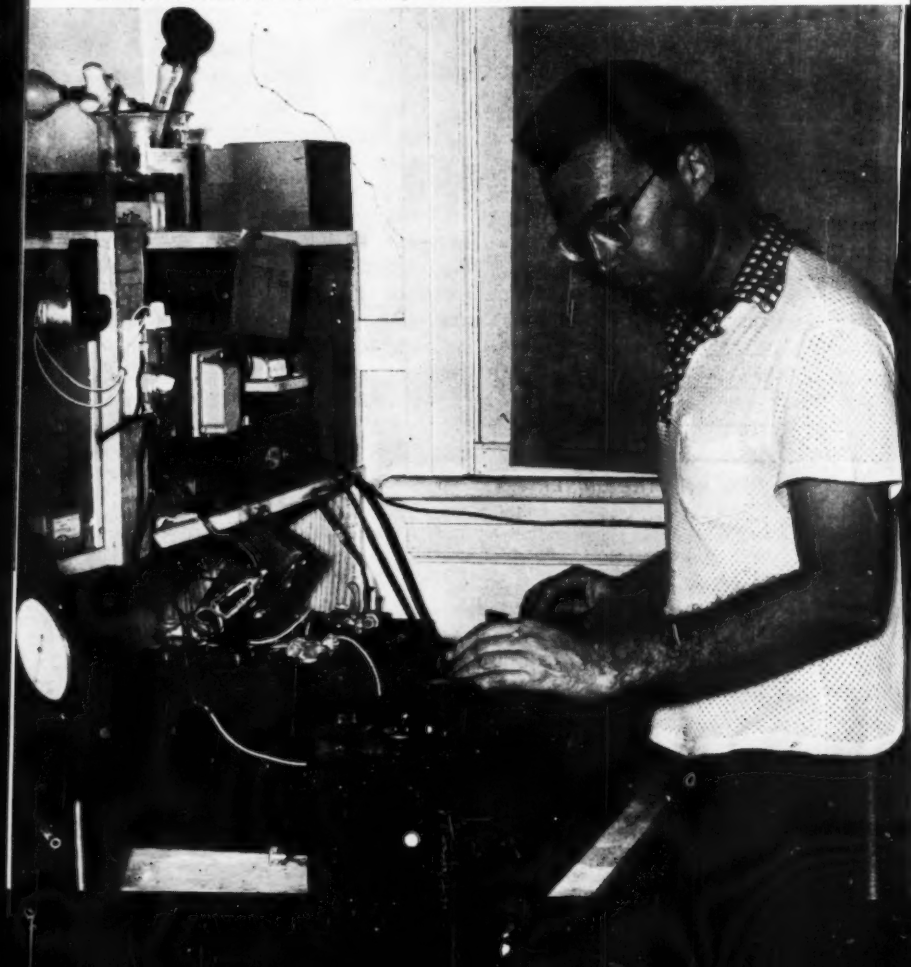
But the application of science to the development of engineering or industrial processes is the last step. The first step, the basic scientific knowledge and discovery on which our technical developments depend—this can only come about in an atmosphere of intellectual freedom.

The development of a commercial process is a relatively well organized affair but the discoveries of basic science can never be so. The results cannot be predicted in advance and can only come about as a result of the free enterprise of scientific curiosity applied to the unknown. The scientist cannot open up new horizons if he is hampered by formal directives or circumscribed contracts. The great discoveries are made by individuals. Thus it is that the first steps of scientific discovery must come from independent institutions.

The International Oceanographic Foundation

The Foundation was established for the purpose of supporting and encouraging oceanographic research and, in particular, the free scientific endeavors of scientists rather than the

THE SPECTROPHOTOMETER *provides a useful tool in the biochemical and nutritional studies involved in plankton research. Leonard Greenfield routinely examines numerous samples brought back from ocean cruises, both from plankton studies and Red Tide investigations.*



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organized application of scientific knowledge already gained. Its aim is not to carry out research itself, but to support and encourage unfettered scientific exploration by independent institutions.

Only such efforts as this can supply the stream of scientific discovery upon which the technological, industrial and governmental developments of the future will be based.

The Foundation is not a government or State controlled agency. It is a committee of those who are interested in the ocean and in the development of basic sciences of the ocean for the welfare of all, and the insurance of our future.

RIPPLES

The Sun, The Sea, and Tomorrow

How much food can a hungry world obtain from the sea? There are millions of acres of saltwater teeming with plankton, the ocean pasturage, but can we ever hope to extract this huge food potential? Or can we expect to use electrified nets, fish detectors, underwater "radar" and other new devices to increase the yield of fish?

On land our basic minerals are being consumed but not replaced. Yet in one cubic mile of seawater there are several tons of uranium and gold, about 25 tons of copper, manganese, zinc and lead, and 300,000 tons of bromine. And the ocean contains not one cubic mile, but 300,000,000 cubic miles of sea water. What new chemical methods and devices are necessary or likely to develop for extracting the great mineral wealth of the sea?

These are the questions, among others which *The Sun, The Sea and Tomorrow* sets out to answer, in layman's language and with illustrations. This new book is written by Walton Smith and Henry Chapin, authors of *The Ocean River* and is published by Charles Scribners' Sons.

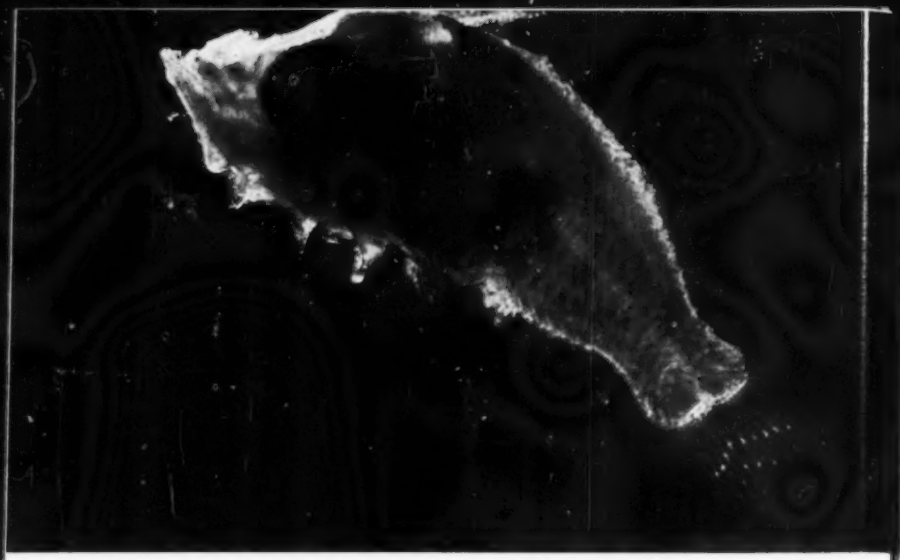
Unusual Specimen

Found for the first time in the continental United States, *Ucides cordatus* (Linnaeas), a member of the land crab family, has been accessioned into the museum at the Marine Laboratory. The specimen is a relative of the common blue land crab usually encountered in south Florida.

The unusual specimen was found near the laboratory building on Virginia key and was taken to Gil Voss, senior research assistant, for identification.

"It is the first of record to be found in the waters of the continental United States," says Voss. "It heretofore has been known only from Cuba to Brazil but not known to the oceans farther north."

Voss expressed the opinion that the crab might be a straggler, or there may be more of them here as yet not located. *Ucides cordatus* is easy to identify because the claws are slender and the legs are hairy, unlike the common blue land crabs that scurry onto lawns and across roadways here. These have large claws and very little hair on the legs. The new crab has red legs and a brown and blue back.



APPEARING *like a big eyed monster from the deep, this fellow is not as awesome as he seems. Actually, he is less than an inch long and is one of the larval specimens recently brought in and studied by Gil Voss and his group.*

The Smallest Catch May Be The Greatest

by HILARY B. MOORE

PLANKTON was no more than another of the scientists' queer words to the public of a few decades ago. Today it is almost becoming common usage. People are realizing more and more that the small animals and plants which drift around in the ocean — and in fresh waters, too — are something important which affects their everyday lives. You can see why a fisherman, for example, might be interested in plankton, but why should the Navy's submarine hunters, the chamber of commerce of a coast resort or a big petroleum company? To answer this we must understand something of the workings of the food chain in the sea.

Gardeners today talk learnedly of 5-10-5 mixtures, trace elements and humus where their fathers just knew that farmyard manure helped plants to grow. They see how phosphorus and nitrogen are taken up by the plants and built up into vegetable tissues. They are all too apt to see the next step in the food chain when a multiplicity of grubs convert their best plants into animal tissue. The farmer goes further and can tell you the percentage efficiency of cattle, hogs and chickens in converting plant material into animal material. But these plants and animals are living all around us and are big enough to see. We are apt to forget the other links which join the chain into a circle, the bacteria which are continually breaking down plant and animal tissues back into the phosphates and nitrates that we started with.

The sea is less accessible to most of us and the only life most of us see in it are the fishes—a single link in

the food chain. All the other links are there, just as on land, but less obvious. And, just as on land, the fertilizer feeds the plants which feed the cattle, which feed us, so in the sea we have fertilizer, plants, plant-eaters and carnivores. Only most of these are small, unnoticeable forms which we call plankton.

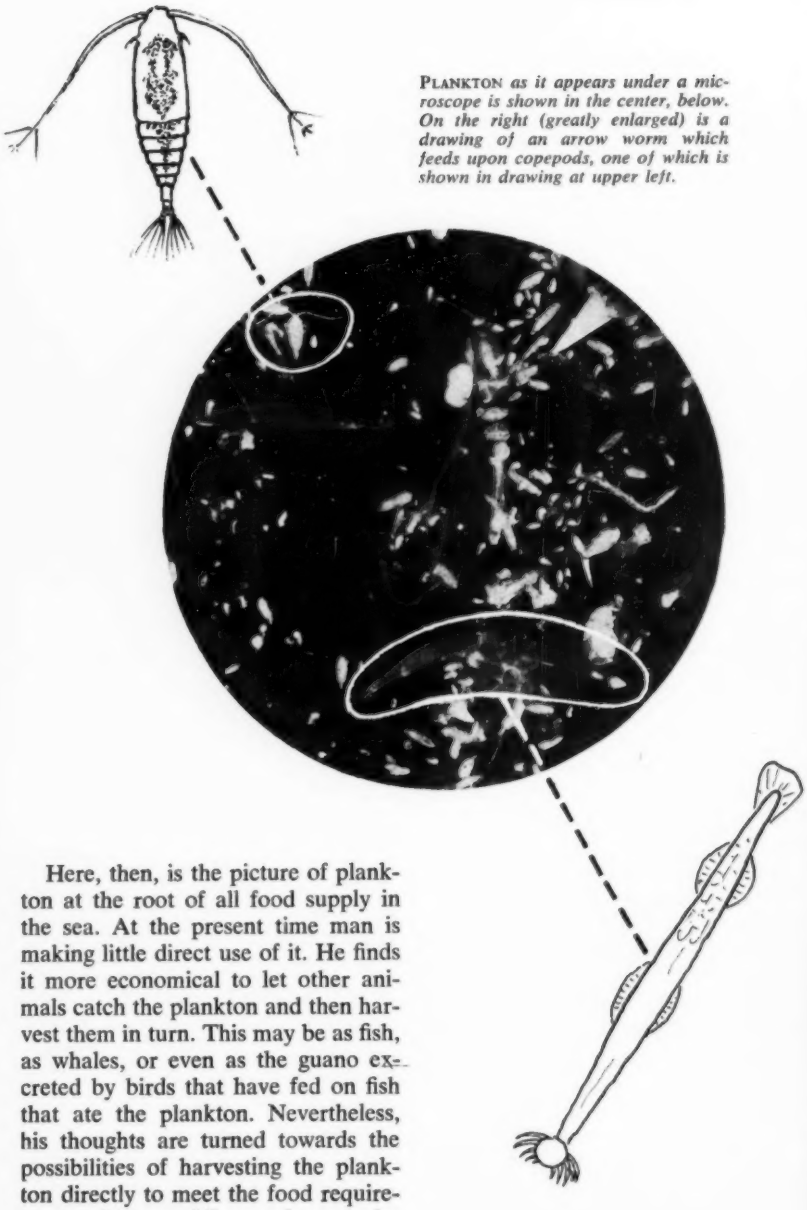
Fertilizer From Below

Deep in the ocean, too far down for light to reach, there can be no plant growth as we generally think of it and the animals must find their food in dead bodies sinking from upper levels. Yet these same animals die and bacteria break down their tissues so that phosphates and nitrates accumulate where there are no plants to make use of them. As the oceans circulate, there are parts of the world where these rich, deep waters find their way to the surface. They come up into the zone which sunlight can reach and here the planktonic plants are ready to make use of their nutrients. These plants are very unlike the land equivalents. They cannot have roots since there is only water to attach to and they cannot be heavy or they will sink into the dark depths where they will die. The Sargasso weed takes care of this sinking problem by growing air floats which buoy it up at the surface. Most of the plant plankton, though, has evolved as minute forms, so small that their sinking rate hardly matters. Many have added slender spines to slow down sinking still further. And most have built up oil droplets inside to help float them. Others are naked and unprotected. Of the latter, most are so small that we cannot strain them from water with nets or even ordinary filter papers. They go right through and we have to use a centrifuge or specially fine filter to catch them.

The plant-eating animals of the plankton have no such difficulties and have beautifully designed filtering mechanisms for straining the plants from the water. This is their food and they thrive on it. Where the ocean upwellings bring nutrients to the surface we find the plant plankton flourishing and the herbivores in their turn in great concentrations. What are these herbivores, the plankton equivalents of our mice and rabbits and cattle?

Grazers on a Liquid Pasture

First of all there are the copepods, perhaps a quarter of an inch long—shrimplike little animals whose front legs are fringed with hairs to filter the water. Then there are the euphausids, also shrimplike, but a half to two inches long. There are true shrimps too, and the young stages of crabs and barnacles and a host of others. They can swim well enough to move around in the water and even to move up into the richer upper waters at night. In the daytime they swim down again though, avoiding the bright light that is so necessary to the plants. Still another link along the food chain are the carnivores which prey on these plant-eaters. Many of them are themselves planktonic — arrow worms, jellyfish and the young stages of many fish. There are bigger carnivores that come into the picture here, though. Herring and mackerel strain the small herbivores from the water. So do others right up to the giant blue whales whose stomach may yield a truck-load of euphausid shrimps. That plankton is rich food is shown by the fact that these giant whales may reach adult size in five to ten years.



PLANKTON *as it appears under a microscope is shown in the center, below. On the right (greatly enlarged) is a drawing of an arrow worm which feeds upon copepods, one of which is shown in drawing at upper left.*

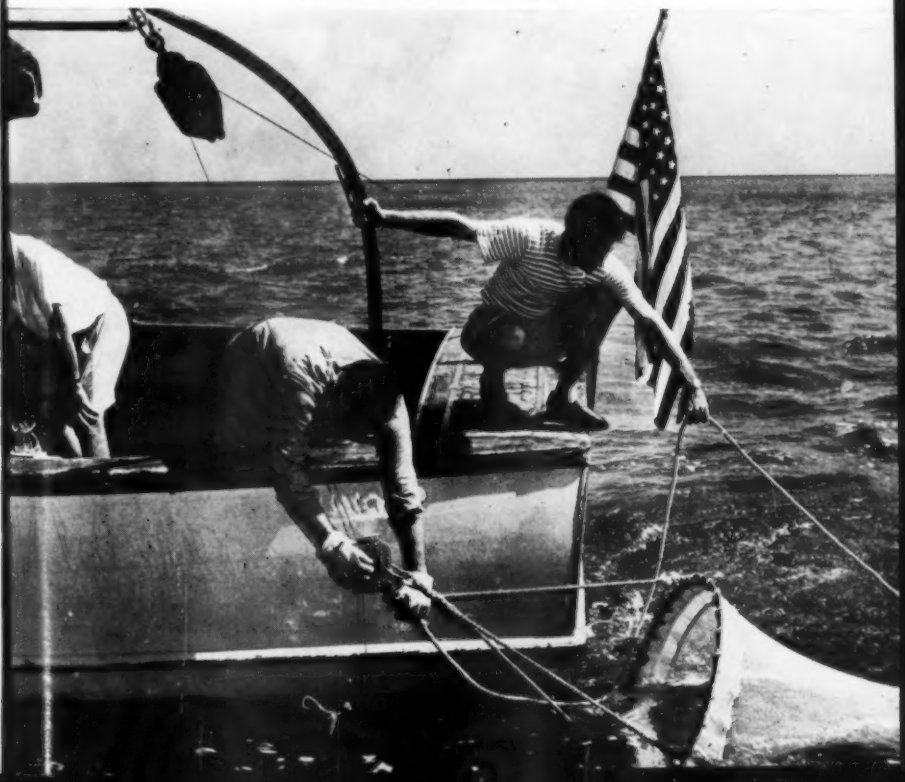
Here, then, is the picture of plankton at the root of all food supply in the sea. At the present time man is making little direct use of it. He finds it more economical to let other animals catch the plankton and then harvest them in turn. This may be as fish, as whales, or even as the guano excreted by birds that have fed on fish that ate the plankton. Nevertheless, his thoughts are turned towards the possibilities of harvesting the plankton directly to meet the food requirements of the world's growing popula-

tion. And he knows that each stage in the chain involves loss of energy—about 90% loss—so that it would well repay him to harvest his sea food at its source if he could.

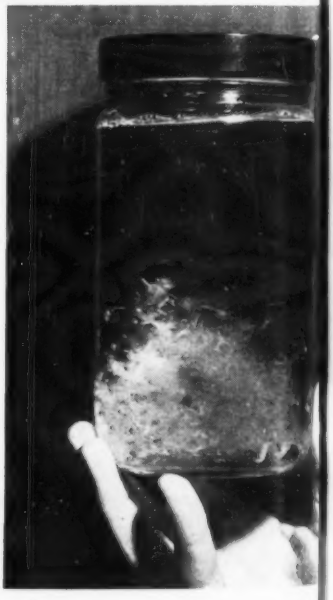
New Importance

This is one reason why so much marine research is centered around the plankton. We must know the ocean circulation to understand the flow of nutrients to the plant plankton. Then we must understand the physiology of the plankton and learn its interrelations with the higher forms which prey on it. The fishing industry is concerned with the plankton not only as a food supply for the fish but also as containing the eggs and young stages of many of the fishes themselves. The petroleum geologist is tracing the accumulation of organic matter on the floor of the sea, rained down from the plankton overhead, and later to be buried and perhaps transformed into oil. The Navy, tracking submarines by underwater sound calls for more information than we yet can give on the concentration of plankton from which sound may echo back to the submarine hunters. These are just a few ways in which normal plankton enters into everyday affairs. When plankton ceases to be what we consider normal and some particular form runs riot, we may have as serious a situation as we find in the well-known "Red Tide" outbreaks. There, a small plankton plant, or perhaps animal, for it shares characters of both, takes control and secretes poisons which may kill mil-

A PLANKTON *net goes overboard.*



THE NET *comes back.*



THE CATCH *of plankton.*

lions of fishes. As these drift ashore they are a major headache to the chambers of commerce trying to tell the tourists of the attractiveness of their local beaches.

Our knowledge of land farming has grown up for thousands of years, even if the scientific approach is much younger than that. The study of sea farming is almost new by comparison. Those engaged in plankton research realize how small their effort is compared with the exploration that urgently needs to be made. The volume of their research is growing but by no means fast enough to keep pace with the call for information.

Trailing Ocean Gamesters

by GILBERT L. VOSS

POSSIBLY THE GREATEST common interest of all sportsmen is a deep love of Nature, an insatiable curiosity concerning their game, and a never ending search for new grounds, larger and faster game, and fine tackle. Unfortunately it is often difficult for them to indulge in work which brings about an addition to our knowledge of most of these things. But for the sport fishermen of south Florida such information is now becoming available.

In the world of ocean game fishing Miami holds an enviable position in the center of what might be called the "hub" of the great sport fishing center of the Western Atlantic. Within a few miles of her docks sailfish are caught the year round, the white marlin is a frequent visitor and the giant blue marlin's home lies only forty miles away on the other side of the Gulf Stream. In the spring the giant bluefin tuna sweep northward past Cat Cay and Bimini bringing anglers from all over the world to test their brawn and skill in that great classic of the fishing world, the Cat Cay Tuna Tournament.

Closer to home in the waters bordering the shore are found the bonefish, perhaps the swiftest of sport fish, barracuda, wahoo, king mackerel, dolphin, cobia and many others.

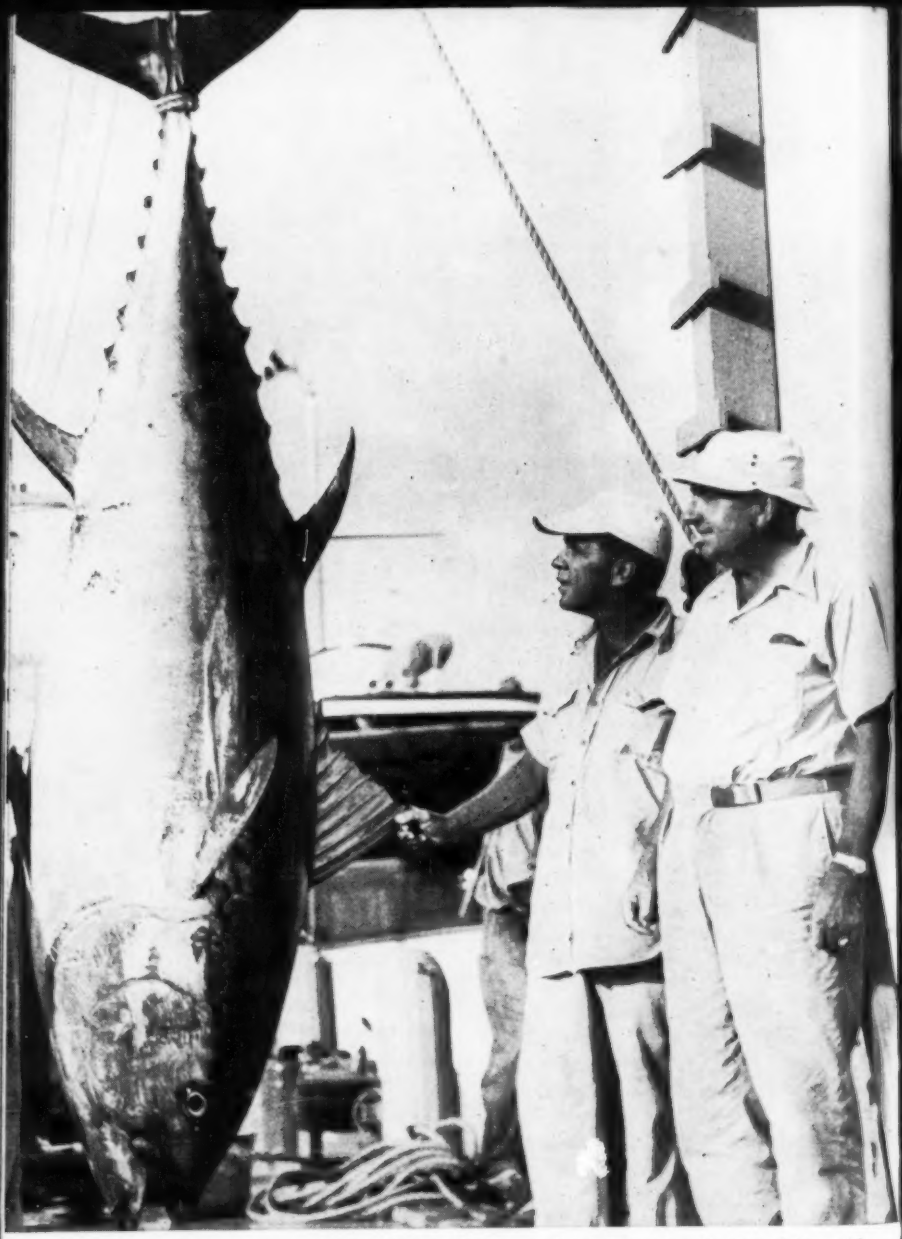
With such a backdrop for their work it is perhaps no wonder that the interests of scientists were early turned to many of the problems connected with the sport fishing world. Sport fishing is one of the biggest industries in the state of Florida. Its lure brings many thousands of visitors to our hotels and keeps a large and expensive fleet of charter boats equipped with the finest tackle and operated by men who are specialists in the art of angling.

Anglers are inquisitive people and keenly interested in their sport. They also are aware that their very interest may possibly lead to the depletion by overfishing of the fish that they so highly prize. They are conservationists at heart, needing only advice and knowledge of how to put their power of numbers to best advantage.

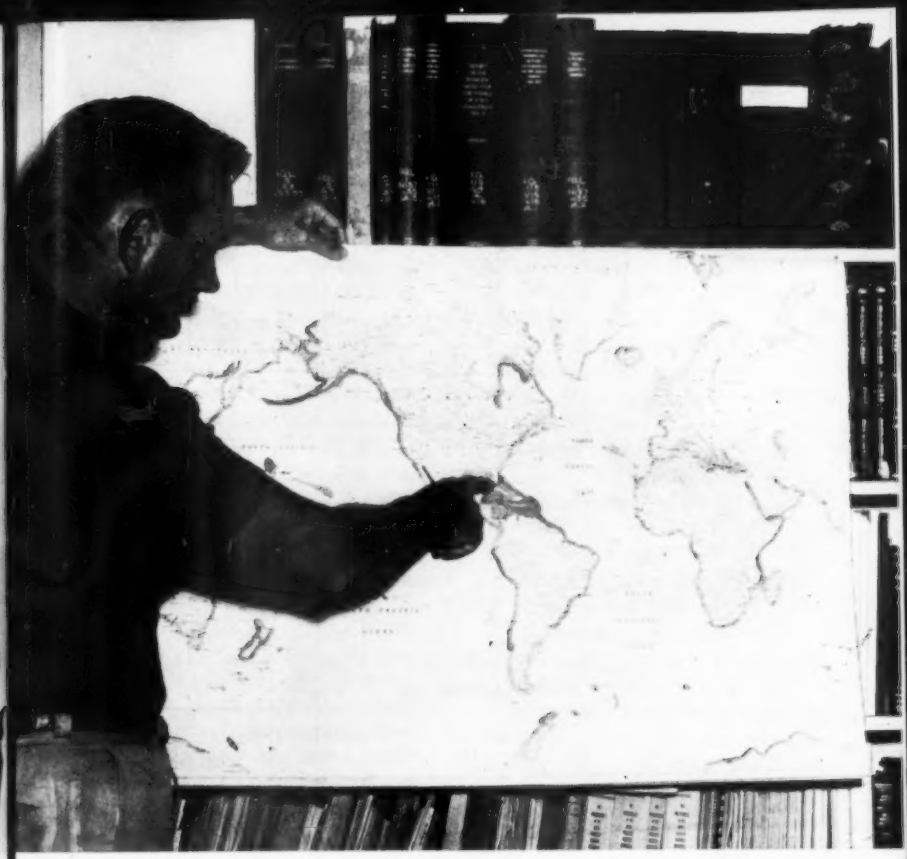
Sailfish Tagging Program

For many years sailfish anglers from Stuart to Miami have been interested in releasing their sailfish after a hard fought battle in the hopes of catching him another day. But if they release him after being brought to the boat, *would* he live to fight another day or would he die or fall prey to some non-conservation minded shark? In poor years anglers claimed the sailfish were decreasing in numbers, threatening the very heart of the sport and the preservation of the species. Older sportsmen said that the numbers of sailfish along the coast could never compare with those great schools of earlier years. Was there depletion and if so, what could be done about it?

In 1948 some of the fishermen and sportsmen asked the help of the Marine Laboratory in solving their problems by initiating a program of sailfish tagging.



CHARLES F. JOHNSON, *on right, President of the International Oceanographic Foundation with his guide "Whippy" Foster and his catch, a giant bluefin tuna.*



GIL VOSS *points out the areas of ocean in which gamefish research is at present being carried out. Luis Rivas has just returned from work in Chile and Peru. He has also studied billfish in Panama and Mexico, bluefin tuna in the Bahamas, Nova Scotia, England, Denmark, France and Spain. A considerable amount of study has also been made at home on the Florida sailfish and snook by Rivas, Gil Voss, Robert Young and others of the Marine Laboratory staff. Col. J. K. Howard is now setting out for Australia and South Africa.*

This request was considered for some time before a reply was given. It was known that sailfish and marlin tagging had been tried many times without success. In the Gulf of California several thousand sailfish had been tagged without a single return. Also, tagging alone was not sufficient to solve the problems that the sportfishermen, led by Charles F. Johnson and Lansdell "Bounce" Anderson of Palm Beach had presented. They wanted to know where the sailfish lived, where and when they spawned, how they grew up, what the small fish looked like and where they went.

A comprehensive line of attack was finally drawn up and funds obtained from sportfishermen and the State. At the laboratory the work was originally carried out by the author with the advice and help of Dr. Clarence Idyll, fisheries biologist and Luis Rivas, ichthylologist. With the splendid cooperation of the sportsmen and boatmen a general tagging program was carried out from Ft. Pierce to the Florida Keys using several different types of

tags which were improved as the work went along. Enthusiasm ran high and the program grew to include landing reports, stomach content analysis (with the help of the taxidermists), measurements of fish obtained at the docks. Field workers, now increased in numbers, became familiar sights armed with their giant calipers and metric measuring devices.

The program snowballed. In the same year the first tag return was recorded and since then four tagged sailfish have been taken. At present the program is large and very active, being carried out by Bob Young of the fisheries section of the Laboratory, whose "Sailfish Newsletter" is one of the most popular and sought after publications along the waterfront.

Larval Fish Studies

About the time that the sailfish program was getting well underway, thought was being given to the need for studies of the larvae and young of the other food and game fish in the area. The Gulf Stream had long been suspected to be one of the main means of distribution of these fish in the north Atlantic and a rich source of baby fish of all types. Little work had been done in the United States along these lines but in Europe many important questions involving the life history of fishes had been settled by studying the forms taken from the plankton. Here it was possible to learn the place and time of spawning by catching the eggs and young, and identify the young of many species whose place of spawning was completely unknown. The results could be of great importance.

A start at this work was given by Charles F. Johnson, subsequently aided by the State. In the following year, the National Geographic Society came forward and gave the whole program a tremendous new impetus by setting up a two year project. This supports three workers in the laboratory and provides funds to keep the research vessel *Physalia* at sea supplying specimens. Three workers (the author, Nancy Voss and Joan Clancey) began work on the planktonic fish and since then over 13,000 specimens under one inch in length have been collected and identified to family and several groups have been completely worked up. Among these have been papers on the life history of the sailfish, the snake mackerel, and the lantern fishes. At present, work is still going on and papers are being prepared on the jacks and the unicorn fish. In addition, a great deal was learned about many of the fish by noting the time of their occurrence in the plankton hauls. At the same time, other workers in other institutions were contributing information on the habitats of these young fishes, their temperature, needs, food supply and general biology.

In a cooperative effort with the Fish and Wildlife Service, the Marine Laboratory acting for the Florida Board of Conservation has for several years carried out a study of the early stages of the swordfish. A Laboratory biologist, George Arata, working on the Fish and Wildlife Service research vessel, *The Oregon,* collected immature stages of the swordfish. A complete report of his findings has recently been published.

Bluefin Tuna Program

With the sailfish studies progressing so well it was only a matter of time before the giant bluefin tuna came into the picture. Again it was through the unflagging interest of Mr.

Charles F. Johnson that the program for these fish began. For many years Mr. Johnson had chased bluefin tuna off Cat Cay in the Bahamas and like many another had been captivated by the great schools of giant fish pouring over the edge of the dropoff, streaming northward in a wild migration that neither shore, anglers in speeding boats, nor spotter airplanes could halt. Where did these great monsters come from and where were they going? Was it true that these fish would soon show up along the coasts of Nova Scotia? Were they the same species as those found along the coast of Europe? These problems bothered Mr. Johnson.

A two year grant was set up by Mr. Johnson for the study of the bluefin tuna and the work began under the direction of Luis R. Rivas. Since then each of the Cat Cay tournaments has been attended by teams of workers who measure the fish caught during the day, cut open the stomachs to search for the food of the giants, and examine the gonads to determine the time of spawning. Tagging methods have been devised and tried out at each yearly run. It is exciting work crowded into a space of only a few weeks in late spring and early summer.

Luis Rivas was not content to ask fishermen questions and plot recorded data. The first year a cruise was made, in advance of the tuna run, on board the Laboratory's vessel along the edge of the Stream. Luis searched from Cat Cay to Havana, Cuba, and back for fish and tested the deep waters with a Japanese long line. Much was learned but the migration was not discovered.

Not to be discouraged, Luis changed from a surface boat to the air. For three years he has cruised the Caribbean and the Gulf Stream with the Coast Guard as an observer on their routine flights from Miami to Puerto Rico and Jamaica, noting the presence of the fish and photographing them from the air. During the tournaments Luis tagged fish aboard the Laboratory's vessel and charter boats. This was only part of the picture.

Research on such a subject is built up from the contributions of many workers in different laboratories. The Oceanographic Institution at Woods Hole has for some years been studying the tuna on the northern part of their migration. Mr. Frank Mather, III, has collected and tagged them along their route, and contributed much to their understanding. Observers all the way from the West Indies north have played their part.

One interesting finding made recently by Luis Rivas has been that tuna appear to have a transparent area on top of the head. Although no definite proof has yet been available, an attractive theory exists that tuna sense light through their "hole in the head" and that this light reception may have some effect upon migration.

Billfish Studies Abroad

While it has been a rule at the Laboratory that work be restricted to tropical western Atlantic waters, in the enthusiasm and publicity resulting from the sportsfishing investigations it was only a matter of time before operations were greatly expanded. This came about through the interests of three people: Mr. Charles F. Johnson, Col. John K. Howard and Lou Marron.

Col. Howard, who is no mean scientist himself, became interested in billfish problems the usual way, from the seat of a fighting chair, gripping a bending rod and listening to the

scream of the swiftly disappearing line. He is interested in the ecological problems of the billfish, from both the sporting and commercial angles. He is interested in the distribution of the billfish, where they spawn, what they live on, and what factors, such as salinity, temperature, ocean currents, etc., cause the definite limits to their ranges. Some areas which by his theories should support large numbers of billfish have had none reported. Why?

In the few years since Col. Howard came to the Laboratory he has made some remarkable headway in solving these problems. He has accumulated thousands of reports of billfish from all over the face of the globe through his voluminous correspondence with interested people and friends. In addition, he has organized and carried out several expeditions which have led him to New Zealand, Australia, Fiji, Tahiti, Jamaica, Mexico and many other places. He has collected fishes for the Laboratory and obtained information on the distribution and movements of the billfish. Even as this is being written he is on his way to East Africa to catch and collect specimens of billfish along the eastern coast of the "dark continent." He hopes to catch and keep valuable fish in cold storage until they can be measured by Luis Rivas for comparison with Pacific and Atlantic forms.

Lou Marron Pacific Billfish Expedition

Lou Marron, internationally known sportsfisherman, had other problems worrying him. The west coast of South America is known to have some of the largest marlin and swordfish in the world swarming in its waters. Only a few spots have been fished with adequate gear but many world records have been broken in these cold waters bordered by the Humboldt Current. Are these giants found all along the South American coast or are they restricted to the known areas?

Under the auspices of the Laboratory, Luis Rivas, with the advice of his fellow workers, set up plans for a long term investigation in these waters, plans that call for five years of exploratory cruising along the coast of South America. A specially designed boat was built by Lou Marron and shipped to Central America and there, in the spring of 1954, the expedition assembled. The personnel

THE GIANT SQUID, *held by expedition leader Lou Marron, provided special nerve material shipped on dry ice to the Massachusetts Institute of Technology for experimental purposes.*

MEASUREMENT *of giant billfishes is not the most comfortable of tasks—unless you sit astride the fish like a horse! Luis R. Rivas is shown measuring depth of body of large striped marlin in Iquique, Chile during Lou Marron—University of Miami Pacific Billfish Expedition in June, 1954.*

consisted of Luis Rivas, ichthyologist in charge of the work, Mr. and Mrs. Marron, Mr. and Mrs. John Manning, well known California big game fishermen, Capt. Howard Thuet, an experienced west coast sports fishing guide, and other scientists who carried on research partly aboard the vessel and partly on the material brought back.

The area offshore from the coast of Chile and Peru is also being investigated by a research team from Yale University. The sum of knowledge gained by all groups should not only substantially advance our knowledge of the waters but also add to our understanding of the biology of the billfish.

In the first year which has just ended the waters of the Eastern Pacific from Central America to Chile were investigated and dozens of billfish were caught; also striped marlin, black marlin, sailfish and swordfish. All available data were collected in conjunction with the caught fish, temperatures, salinities, currents, plankton samples, etc. The first year's operation has been highly successful, just how much so is beginning only now to become apparent as the written reports come in from the various scientists engaged in analysis of the collected information. Billfish are so numerous in the area that a large commercial fishery is supported and one part of the study deals with this important phase in some detail.

Snook Investigations

From the emphasis so far placed on the big game fish the question might arise as to what, if anything, is being done about the small fish, the working man's game fish? One of the most popular game fish in the Miami-South Florida area is the snook, an inhabitant of the shallow coastal waters, bays, lagoons, and rivers.

In the last few years the snook has appeared to be on the decrease and the sports fishermen have become alarmed over the possibility of the fish disappearing completely by overfishing. In answer to the queries of "What can be done to save the snook?" Arthur Marshall of the fisheries section entered the picture and in the last year and a half has been studying the snook, its life history, food, spawning, movements and numbers. Although the study is still incomplete, Marshall is piecing together the parts of the puzzle as his investigations turn them up and it is hoped that concrete advice may soon be at the disposal of those who write our fishing laws.

Two years ago a new problem arose in connection with the snook, through the rise of a new fishing sport, underwater spear fishing. This, one of the most exciting of personal encounters with fish in their native habitat, was causing what appeared to be undue slaughter of these fish by the spear fishermen. It was feared that snook numbers might be depleted for the more conventional angler. A study of the situation made by Winfield Brady of the fisheries section showed that by proper control of the sport by the spear fishing clubs themselves, harmony could prevail.

The disputes between anglers and spearfishermen, like those between commercial and sports fishermen, are matters to be settled by better understanding of the situation. Where relations have improved, the scientist has often played his part by bringing proven facts into the arguments — facts which sometimes have come as a surprise to both parties.

Coordination

The program carried out from Miami is one of the largest sports fishing investigations in progress anywhere today. As is true in any project involving many specialists, coordination of the efforts of the scientists is the prime key to success. The various phases may be summarized as 1) studies of hydrographic conditions consisting of temperatures, salinities, water masses and their movements, 2) tagging in order to ascertain growth rates and migrations, 3) gonad sampling for spawning time and areas, 4) stomach analysis for food studies, and 5) plankton sampling in order to obtain the young and eggs for studies of early development.

It is believed that with the present program the questions posed by the sportsfishermen can eventually be answered and sound conservation laws, when needed, be proposed.

In carrying out the studies, over 10 scientists at Miami alone are engaged in laboratory and field work. Planktologists, oceanographers, systematists, biochemists, commercial fisheries specialists and various consultants serve. In addition, sport fishermen and charterboatmen provide valuable advice and help.

The present program is only a beginning—who knows what the future may bring in new discoveries?

PROGRESS

The Virginia Key Building Program

Scientific progress is primarily the result of man's curiosity and imagination. For this reason the scientist himself is the most important ingredient. Without the right type of scientific personality the most elaborate building and equipment are valueless. Nevertheless, however used to working on a shoestring and no matter how skillful a scientist may be in improvising apparatus and equipment there is always a certain minimum of physical plant needed. Moreover, working without proper facilities may greatly reduce the time which can be spent in useful research. Accordingly, efficiency drops.

In the case of The Marine Laboratory the scientific staff has for several years worked in buildings located several miles from the sea. Much of the research program of a Marine Laboratory may be done in any building, whether near the shore or not. But there is a certain minimum amount, particularly where living fishes and other marine organisms are in use, which requires running seawater. Hence the need for modern buildings properly designed for oceanographic research grouped together next to the sea.

The Virginia Key site consists of over six acres at the right of the Rickenbacker Causeway as it crosses the bridge at Bear Cut. It provides ample land for the completion of what should become the most up-to-date laboratories for marine science in the country. It is hoped that, with two buildings already erected or in course of erection it will soon be financially possible to begin the main laboratory building of the program.

The two buildings shown in the foreground are designed for saltwater circulation. The building on the right is already completed. The laboratory on the left is the Alexendrine Dupont Collier Building, similar to the existing one. Behind these is the main building which will house the library, biological, chemical, geological, and fishery biology laboratories and administration. Other smaller buildings will house the workshops. It is also hoped later to include an oceanographic museum which will demonstrate in modern fashion the latest discoveries in oceanography.

One of the principal interests of the Foundation is to make possible the provision of adequate buildings and adequate scientific equipment and research vessels for an energetic oceanographic research program.

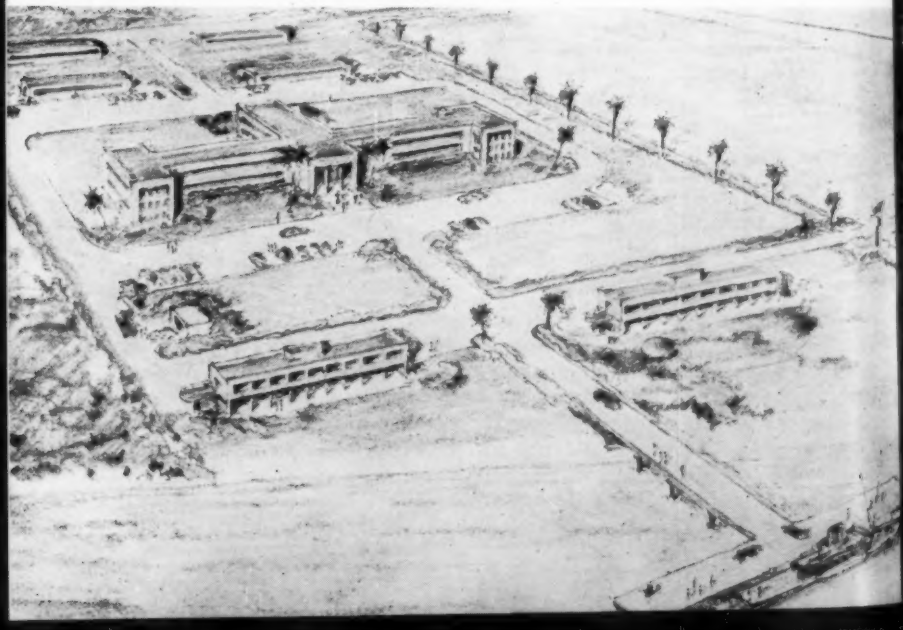
ARCHITECT'S DRAWING *of proposed Marine Sciences Campus. Building in right foreground has been in operation for over a year. Building shown in left foreground is the Alexendrine DuPont Collier building which will be ready for occupancy early in 1955.*

The Alexendrine Dupont Collier Laboratory

The Alexendrine Dupont Collier Building will soon appear as part of the permanent building program of the Marine Laboratory of the University of Miami. The contracts were let at the end of October and it is anticipated that the building will be ready for occupancy early in 1955.

Mrs. Collier was actively interested in the marine sciences and it is only fitting that the building, which bears her name should be part of an "oceanographic campus" which is becoming a landmark for marine research in the tropics. Mr. George Collier whose interest and generosity made this building possible also, with Mrs. Collier, helped very materially with the first laboratory building. The latter building has been in full operation for over a year.

Both buildings are especially designed for their purpose. All salt water conduits are of plastic which resists corrosion and also ensures that



the water will be completely free of materials poisonous to sea life. Chemical reactions in metal pipes often produce noxious substances. Drains are open troughs at the sides of the building so that saltwater equipment may be quickly moved about without having to uncouple piping. The structure of both buildings is such that they may be adapted for radio isotope work, classroom study, and physiological investigations. Equipment may also be installed for biological or chemical routines. Since there are no internal walls, the arrangement of laboratory space is completely flexible.

FOUNDATIONS *for future research. Driving concrete piles for the Alexendrine Dupont Collier Building.*

FLORIDA FISHERY RESEARCH

THE FLORIDA STATE BOARD of Conservation has a great task to perform in the study of the State's salt water fisheries. For the past eight years the board has turned to the Marine Laboratory to do the job.

The program includes, among other projects, tagging, life histories, and study of populations of mullet and spiny lobsters, the location of new shrimp fisheries and better methods for the handling of shrimp, collection of fishery statistics for the entire State, and an investigation of the Red Tide.

Red Tides have killed hundreds of millions of fishes in Florida's seas and have been the object of serious study since Charles Davis discovered and named the causative agent, *Gymnodinium brevis* in 1947.

In addition to economic research for the Florida State Board of Conservation, the Laboratory aided by the sports fishing interests, has instituted a program of tagging sailfish and a considerable amount of study on the game fishes including the bluefin tuna.

Also relating to Florida's seas and the economy of the State is the program of research on plankton, the drifting life of the sea. Most of this is carried out under a four-year grant from the Rockefeller Foundation in New York. The importance of this work is that all seafood potential is based on plankton.

Another grant from the U. S. Public Health Service is being used to study the effects of pollution in Biscayne Bay, while under a contract with the U. S. Army Engineers a survey has been made to determine effects upon marine life in the Stuart and Fort Myers areas of releasing water from Lake Okeechobee. Under a grant from the National Geographic Society fish are being collected in larval and egg stages to complete wide gaps in scientific knowledge of their life histories.

A great part of these research programs beneficial to the state of Florida are being carried on through outside grants at no cost to the taxpayers of the State. Also, without any State or Federal aid for buildings, laboratory equipment, boats or any other capital expenditures, the Laboratory has pursued a large program of research on a broad scale impossible to most small and highly specialized state fishery departments. All this is done in Miami without any carrying charge for capital investment. This is a tribute to the private enterprise system and the support of the individual fisherman and citizen.

Keeping almost the whole staff in the field or at the laboratory work tables, the Laboratory has also enjoyed freedom from political pressure, changes in administration, personnel or policies, and has been free of so-called governmental red tape. Results per dollar of cost, it is said, have never been bettered in the long history of fishery research.

Red Tide

SINCE 1947, when an unusually severe outbreak of the so-called Red

Tide occurred off the lower west coast of Florida, the Laboratory has studied this marine phenomenon that has accounted for the deaths of hundreds of millions of Florida's fishes. This research, in a greatly stepped-up program, is now part of the work being done for the Florida State Board of Conservation.

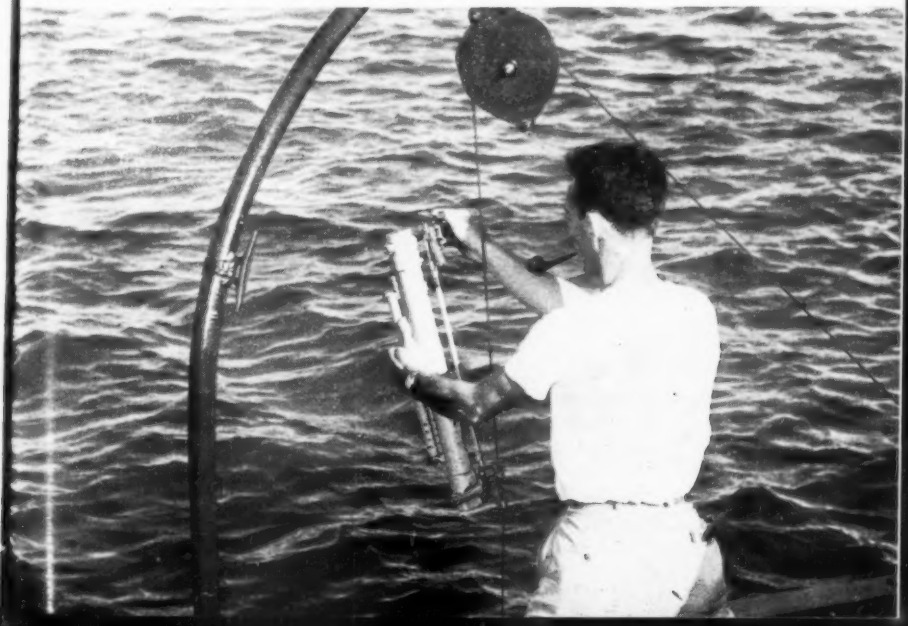
In the preliminary investigation of the Red Tide, which received its name due to the reddish discoloration of the water accompanying these outbreaks, laboratory scientists discovered and named the killing cause, an animal now known as *Gymnodinium brevis.* This marine organism is microscopic in size but its numbers increase beyond all measure under Red Tide conditions.

Gymnodinium brevis is an organism that possesses both animal and plant characteristics. Less than 1,000th of an inch in length, it belongs to the group known to science as dinoflagellates. It moves through the water by means of two flagella, or whiplike projections. Since it is capable of motion it is considered by zoologists to be an animal. However, since it manufactures its own food, it is sometimes considered to be a plant.

As yet, it is not definitely known how a concentration of this organism kills fishes. However, in all probability, the fishes are not suffocated but are killed through the release of a neurotoxin. In the studies and research of these phenomena pursued by the scientists the investigation has taken many forms. At the present time, however, there are three main avenues of investigation emphasized by these scientists. These are (1) hydrographic and chemical (2) statistical, and (3) laboratory culture.

In the first, water samples in the affected areas are taken and analyzed

SPECIAL INSTRUMENT *for taking deep water samples and accurate temperature measurements is lowered into the Gulf of Mexico during Red Tide investigations. A study of temperature and salinity is used to determine the strength and direction of currents and this in turn helps to predict the probable course of a Red Tide outbreak.*



for salinity, temperature, inorganic and total phosphorus content. Salinity is taken to ascertain the effect of fresh water in these areas, while the phosphorus content is indicative of potential biological activity, very important in any biological survey in the ocean and often known as a limiting factor.

Phosphorus is a nutrient or fertilizer that makes it possible for planktonic organisms to bloom. The greater amount of nutrient in the water the more intense growth and multiplication of plankton, of which *Gymnodinium brevis* is a form. Water temperature is important in determining where marine organisms live and, with salinity, is used to calculate ocean currents which, in turn, are important in determining movements of the Red Tide.

In the statistical set-up, data on total rainfall and the occurrences of major Red Tide outbreaks were included. An attempt was made to correlate rainfall in each drainage region with these outbreaks. In this connection, a very good correlation was found in the Peace River drainage region and these occurrences.

Culture of *Gymnodinium brevis* was made and kept alive by the addition of certain nutrients in the water but so far it has been difficult to duplicate in the laboratory Red Tide conditions as found in the sea.

It is now thought by Marine Laboratory scientists that there are two major factors in the destructive Red Tides. The first is that *Gymnodinium brevis* originates in offshore waters and is carried by current or tidal action. Secondly, this suitable area is localized in the mouth of the Peace River. It is believed that the phosphorus, or possibly other nutrients tied up with phosphorus, mixes with the *Gymnodinium* laden water, thus producing Red Tide blooms of destructive magnitude.

Many other factors enter into the formation of Red Tide concentrations, all of which are being investigated. Due to the complex nature of these investigations much time will be required before any definite conclusions can be reached. The most promising lead seems to be that the Red Tide outbreaks occur at what is called by the scientists a frontogenic area. This may represent the interface between nutrient rich brackish water and *Gymnodinium* laden sea water.

One method of counteracting the effects of an over abundance of phosphorus in the freshwater streams that flow into the Gulf of Mexico would be to add some cheap nitrogen compound such as ammonium sulphate to the water. This might result in a more rapid utilization of the phosphorus by algae. This algae could then be eaten by various species of fishes, particularly the black mullet.

One of the ideas in this connection would be to examine the possibility of planting mullet in impounded lagoons along the river. Naturally, this would have to be tried out on a rather small scale so that the effect of such planting might be noted. The black mullet being an algae eater would, it is pointed out, lend itself particularly to this experiment. This is one of the many facets of Red Tide prevention that is being investigated by the Marine Laboratory.

In the present investigations Dr. Ilmo Hela, research associate, is in charge of statistical and meteorlogical phenomena; Robert M. Ingle, research assistant, is coordinator of biological studies.

Since currents and tidal effects have

been shown to be of importance in predicting and following Red Tides, two recent projects have aimed at better understanding of these features. Last June, in operation Driftcard, 2100 bright red cards, enclosed in plastic, were dropped into the water offshore between Fort Myers and Bradenton. When these were picked up, either by boats at sea or along shore, they were mailed back to Miami with information about date and place of pick up. From these facts, much information was gained on the effects of wind on such floating objects as dead fish and other manifestations of Red Tide. The return of drift cards was especially gratifying. Forty-seven per cent of those released at sea were subsequently picked up and returned. A larger drift card operation was undertaken recently but the results are as yet not complete.

The U. S. Fish and Wildlife Service is also working on Red Tide. Their laboratory in Galveston is culturing the causative organism under artificial conditions and a new converted motor vessel, stationed in Fort Myers is working on several aspects of offshore hydrographic conditions. Recently, the U. S. Fish and Wildlife Service has continued studies on the possible use of copper sulphate as a killing agent against *G. brevis*. The first of these experiments was made in 1952.

The Sanitary Engineering Section of the University of Florida has been making periodic checks in the Gulf of Mexico for the presence of *G. brevis*. This survey has disclosed that *G. brevis* exists at times in considerable numbers some distance offshore even in the absence of typical Red Tides.

Fish Killing Bacteria

Recent discovery of a fish killing bacteria in the blooms of Red Tides has added another important phase to the Red Tide research.

These bacteria were isolated from the Red Tide blooms in Whitewater Bay on the southwest coast of Florida. In tests made at the Laboratory it has been demonstrated that they are capable of causing fish mortality under controlled conditions. Previously it had been shown that a microscopic marine organism, *Gymnodinium brevis*, was capable of killing fish under Red Tide conditions.

The bacterial specimens recently tested were isolated by standard bacteriological methods from samples obtained at the points of fish mortality and were kept in living culture.

A tank containing four gallons of continuously aerated sea water was employed in the tests on the killing properties of the bacteria. Three separate tests were made, and in all of them other tanks were used as controls to pinpoint the killing properties.

The live fishes used in the first test included two schoolmaster snapper, two sand perch, four killifish and 12 mollienesia. In the other two tests the fishes used were one snapper, two sand perch, two killifish and 15 mollienesia. In all tests the fishes were dead within 24 hours, and the snapper died within five minutes after being placed in the tanks.

Although these bacteria are of the genus *Flavobacterium*, the exact species are not described. Therefore, Selwyn Jack Bein, who conducted the tests, has suggested designating the new bacterium as *Flavobacterium piscicida*, meaning "killer of fish."

"It has been shown that a bacterium isolated from Red Tide water is

MOTOR VESSEL *Physalia being readied at the dock before a cruise into the Red Tide region of the Gulf of Mexico.*

capable of killing certain fishes under laboratory conditions," Bein points out. "It seems plausible to assume therefore that the bacterium possibly had a role in bringing about the mortality associated with Red Tide outbreaks. The relative importance of dinoflagellates and bacteria in causing mortality is not known and should be investigated."

Investigation of this new factor in the killing qualities of Red Tide will be vigorously carried out along with the other known factors now under research and study.

THE BULLETIN

If you like the Bulletin—and especially if you don't—why not write in or call and let us know what you would like to see in the next number. Perhaps you may also have a good idea for a title. *The Oceans, Sea Science,* and *Sea* are some names already offered. You may have a better suggestion.

RIPPLES

Fisheries Institute

The seventh annual session of the Gulf and Caribbean Fisheries Institute was held this year from Nov. 15 through Nov. 19, in Havana, Cuba. This is the first year that the institute has not met in Miami Beach. The change in location was due to a request from the Banco de Fomento Agricola e Industrial de Cuba, which is interested in promoting the Cuban fishing industry. The Development Bank aided in financing this year's meeting.

The Institute again had meetings of the Shrimp Association of the Americas, the Southeastern Fisheries Association and the Atlantic States Marine Fisheries Commission (Southern Section) during the same week as the Institute meeting. This insured a fine attendance from the fishing industry, which has been a notable feature of the meetings in the past.

The Gulf and Caribbean Fisheries Institute was organized in 1948 by Dr. F. G. Walton Smith, director of the Marine Laboratory of the University of Miami. Dr. Richard A. Kahn of the U. S. Fish and Wildlife Service in Washington, D.C., was one of the most enthusiastic proponents of the idea of establishing the Institute. He has been on the Board of Directors from the beginning. Dr. Clare P. Idyll of the Marine Laboratory has been executive secretary since 1949.

The Institute has long since outgrown the regional character suggested by its name and now draws delegates to the meetings from the whole western hemisphere, as well as from Europe on occasion. Last year, when the Food and Agriculture Organization of the United Nations staged a joint meeting, more than 20 countries were represented.

The function of the Gulf and Caribbean Fisheries Institute is to combine two common types of meetings —the purely technical or scientific meeting, and the trade association meeting. At the former, scientists talk to other scientists and fail to get the stimulus of direct contact with those making a living from the fisheries. Problems which need solution may escape the attention of the technical workers.

On the other hand, industry may fail to become aware of the important findings which could be helpful to them. At the meetings of the Gulf and Caribbean Fisheries Institute both groups attend and exchange ideas. An attempt is made to have industry take a large part in the actual proceedings. The results have been excellent and the reputation of the Institute meetings has spread far and wide.

This year's meeting included sessions on insuring fishing vessels, on quality standards for fishery products, on oysters, shrimp, and on fish behaviour.

In Support of Research

During the past year the following grants have made possible the continuation of research in oceanography

at the University of Miami. They are in addition to a very substantial program of contract research with government and industry.

The Game Fish Research Association made a grant for the purchase of instruments. The National Science Foundation supported a study of the behavior of microscopic life in the sea.

Gamefish studies of various kinds were aided by the Charles F. Johnson Foundation, the Lou and Eugenie Marron Fund, and Colonel John K. Howard. A special study of the life histories of sailfish and other fishes was made possible by a grant from the National Geographic Society.

One of the most vital problems in the ocean is the question of how much food it can potentially produce. Studies of this nature were supported by the Rockefeller Foundation as part of a three year program of research.

Pollution of harbors has become increasingly important as the population of the United States grows. In recognition of the wide significance of such problems the U. S. Public Health Service has continued to support investigations at Miami.

The Lederle Foundation and the Shrimp Association of the Americas have given financial aid to studies aimed at getting a better quality of shrimp to the consumer. Michael G. Phipps has made possible a program of shrimp exploration in Cuba.

The Charles F. Kettering Foundation has for some years been investigating the way in which chlorophyll traps the energy of sunlight and converts it into food, a secret which, if discovered, would be of enormous value to science and industry. The Foundation has awarded a grant to the Marine Laboratory for the purpose of studying the microscopic plants which use sunlight in the sea.

Marine Museum

The objectives of the Oceanographic Foundation include the development of a Marine museum in which the sciences of the sea, including the most recent inventions and discoveries will be demonstrated by the modern types of mechanical, electronic and lighting techniques, as a permanent science show window.

Aquarium of The Future

The Board of Trustees is considering the possibility of building an aquarium of considerable size with an unusual and dramatic method of presenting the life of the sea from the large and beautiful tropical fishes to the living microscopical plankton. The aquarium will be planned by a group of the nation's leading marine scientists, aquarium experts and engineers, and may well set a new and revolutionary trend in the design of aquaria, since it will rely neither upon the familiar large porthole tanks, nor the rows of smaller window tanks or outdoor pools. The undersea garden will not be connected with any existing commercial exhibit and will, of course, be operated as a nonprofit institution in cooperation with existing marine research laboratories.

Contact

Several opportunities for cooperation between the Scripps Oceanographic Institute and the Marine Laboratory were developed during a visit to the institute at La Jolla, Calif., by Dr. Hilary Moore, assistant director of the Marine Laboratory.

Dr. Moore's visit was for the special purpose of discussing research liaison between the two laboratories, with particular regard to the Rocke-

feller Research program, a project mainly concerned with economics of the sea.

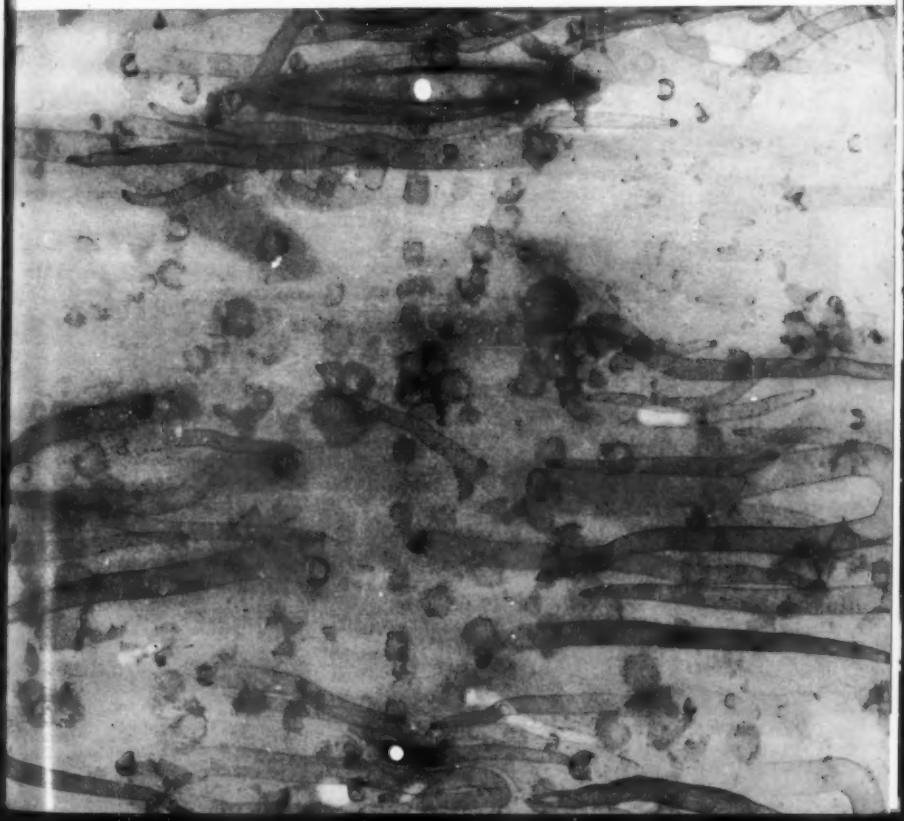
While in La Jolla, Dr. Moore had the opportunity of inspecting two of the Institute's research vessels.

Sea Pests

Numerous telephone calls during the course of a year bring to the Marine Laboratory such questions as "Is it safe to eat puffers?", "What can I do to safeguard against bather's itch?", or "What sharks are dangerous?" In order to answer these and lots of other questions about dangerous or simply annoying creatures in the sea, Marine Laboratory biologists have prepared an illustrated booklet, SEA PESTS. This eighty page summary was printed in September, 1953, and has since fulfilled its avowed purpose of making scientific facts available in non-technical language and of answering some of the questions which naturally occur to those who live or vacation by or on the sea.

Members of the Foundation who would like to have a copy of SEA PESTS may obtain it gratis by writing a note to the Marine Laboratory, University of Miami, mentioning their affiliation.

BIOLOGISTS *interested in growth rate and other vital aspects of shipworm development have understandable troubles since their subjects are always deep in timbers. Lately they have found the new X-Ray machine just the thing for some of these problems. Typical X-Ray view through a piece of wood infected with shipworms is shown below. To a surface inspection the plank seems sound, but actually it has already lost most of its structural strength.*



NEW DEVICES

FISHES were not the only subject under study last spring when the *Megalopa II* took several scientists to Cat Cay for the 1954 Bluefin Tuna Tournament.

One of the new instruments aboard, made by Frank Stephens, head of the Laboratory's electronics division, received its initial test during the annual contest. This scientific aid automatically records conductivity, salinity, temperature and depth of the seawater and is known as the improved C.T.D.

The measurements are made by towing behind the boat some delicate instruments housed in a metal case about the size and shape of a six-inch cartridge used in cannon. This streamlined case is known as the "fish." The "fish" has electrical contact with a recording machine in the boat through the towing cable. Conductivity, temperature and depth are shown on a moving paper roll in the machine in lines of three different colors. These measurements are of great importance in studying currents, especially the tidal currents close to shore or in estuaries.

Although other instruments have been designed for the purpose the new C.T.D. has a number of advantages over previous types.

Gulf Stream Speed

Also at the tournament this year an experiment was made to try to measure the changes in the flow of the Gulf Stream or, to use the more accurate terms of the oceanographer, the Florida Current. To accomplish this a cable was set up from the fresh water lake on the island's golf course to a nearby point in the ocean. Electrodes were placed at each end of the cable, one submerged in the lake and the other in the ocean. The idea was to measure the electrical voltage, which drops as one goes further from the ocean. The rate at which it drops, according to scientists, should be roughly proportional to the amount of water flowing through the Florida Straits.

The tests were based on the fact that the flow of the ocean currents sets up electrical potentials in the sea. Usually this is measured by means of electrodes towed behind a vessel. The voltage recorded indicates the rate of flow of the stream through which the ship is moving, quite independently of the speed of the ship. But a ship cannot continuously measure all parts of the Stream, and so use is made of the fact that the electrical potentials extend beyond the water into the land. If the experiment had been made on the edge of the land closely adjacent to Miami there would be too much electrical disturbance from power plants, radio stations and other installations to obtain a true reading. Cat Cay, however, made an ideal location for the tests.

If these tests turn out well, an automatic recording potentiometer will be placed in one of the Cat Cay buildings so that a continuous long-time recording of the relative changes in the flow of the Gulf Stream can be noted and measured without the use of boats or men.

DR. HILARY B. MOORE *makes final adjustments to the depth distance indicator designed by him for registering the operation of plankton nets.*

CAT CAY

COOPERATION between anglers and scientists for the advancement of marine science is nowhere better illustrated than at Cat Cay, a beautiful island in the Bahamas situated about 50 miles almost due east of Miami. This liaison has been made possible through a standing invitation to scientists of the Marine Laboratory to make use of the island's facilities from Louis R. Wasey and the Cat Cay management.

Throughout the year the scientists avail themselves of the opportunity of pursuing their studies, investigations and research projects at Cat Cay, while the same thing is true of Bimini, 15 miles to the north, where the excellent facilities of the Lerner Marine Laboratory of the American Museum of Natural History are freely and wholeheartedly placed at their disposal.

The annual Cat Cay International Tuna Tournament is a made-to-order opportunity for scientists of the Marine Laboratory At these tournaments many outstanding big-game anglers compete for honors and prizes during a week of fine tuna fishing. The scientists meet and mingle with these men, the majority of whom have fished for various gamesters of the seas, both large and small, in good fishing areas throughout the world.

The knowledge gained by these anglers—not only of fishes but of other sea life, climatic conditions, ocean currents, land facilities and other items—is made useful to marine science in many ways.

Visiting Cat Cay this year at the tuna tournament were the director of the Marine Laboratory; Luis Rivas, research associate and two Laboratory research assistants, Dave O'Berry and Lance Wagner, and Erl Roman.

Large numbers of bluefin tuna, caught by anglers competing in the tournament, were brought to the docks at Cat Cay, where they were accurately weighed. Following the weighing-in process, Rivas and O'Berry took scientific measurements of the giant fish, dissected them and made their notes and records.

The trip to Cat Cay from Miami was made aboard the cruiser *Megalopa II,* a former U. S. Coast Guard crash boat now altered to suit scientific needs.

ACKNOWLEDGEMENT

THE COVER shows the typical Bahamas sloop, *Ambition,* with a gaff-headed loose-footed mainsail as it approaches a mooring close to the shore of one of the out islands. It was taken several years ago during a biological survey of the Island's sponge beds.

Acknowledgement is made to the following sources of other pictures: inside front cover, George Bass; pages 9, 10, 26, 31, *The Miami Herald;* pages 4, 10, 13, 21, David O'Berry; pages 2, 16, 17, Lou Marron Expedition; page 20, Stewart & Skinner, Architects; page 29, Rudolph Simms.

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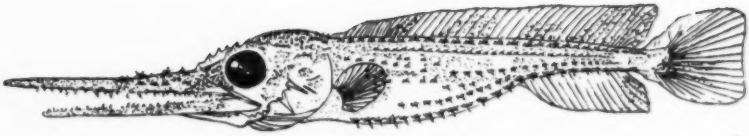

Baby swordfish enlarged five times.